Supernumerary cheek tooth in a Byzantine horse from Theodosius Harbour, Istanbul, Turkey

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Summary

The subject was a mandible belonging to a morphologically mature horse of the late Byzantium period, discovered during excavations at Theodosius Harbor in Istanbul, Turkey that had a developmental molar tooth abnormality, i.e. a supernumerary molar tooth. This is an interesting case due to the rarity of supernumerary molars in archeozoological materials, and also because it is the only such case of equid polydontia from the late Byzantium period from that archaeological site.

Introduction

Animal remains are among the materials most often accquired during exporation of archeological sites (Baker and Brothwell 1980; O'Connor 2000; Davis 2002; Bartosiewicz 2008; Lasota-Moskalewska 2008; Reitz and Wing 2008; Waldron 2009). Animal bone or dental remains from excavations are, mainly because of their stability over time, a source of invaluable information on the anatomy and morphology of the detected species (Bökönyi 1974; Baker and Brothwell 1980; O'Connor 2000; Davis 2002; Bartosiewicz 2008). Because of the presence of multiple skeletons in some sites, they are suitable for comparative, quantitative and qualitive analyses (von den Driesch 1976). These archeozoological findings also indicate the role which domesticated animals had in cultural development of communities at that time (Lasota-Moskalewska 2005), and how domestication affected the biological characteristics of those animals (Bökönyi 1974; Lasota-Moskalewska 2008). They are also a source of information on diseases of animals closely associated with humans (Bartosiewicz 2008; Waldron 2009). However, due to the fact that human consumption remnants prevail in archeozoological materials, animal remains with possible pathological abnormalities, including skull fragments with anomalies, are very rare (Hillson 2005; Lasota-Moskalewska 2008; Reitz and Wing 2008; Waldron 2009; Pasicka *et al* 2012, 2014).

Materials and methods

The analysed material consisted of a right-sided mandible (catalog no. MRY3467), belonging to a morphologically mature horse aged approximately 9-11years old at the time of death This age was estimated by examination of the very well preserved incisors, including assessment of the oval shape of their occlusal surface, and the presence of some of residual infundibula in all incisors (Fig 1). In this paper the Triadan system of equine dental

nomenclature (Fig 3) is used to identify individual teeth (Dixon and du Toit 2011). The well preserved undamaged right mandibular bone had loss of

Triadan 406 and the presence of a caudally situated supernumerary molar tooth (Triadan 412). The attached rostral aspect of the left mandibular bone contained an incisor tooth and a portion of the left physiological diastema (Fig 2a-c). The presence of fully developed and erupted canine teeth confirms it was an adult male horse (Fig 1).

This specimen is a part of a collection owned by Osteoarchaeology Practice and Research Centre, Department of Anatomy, Faculty of Veterinary Medicine, İstanbul University. The mandible was mined during excavation at the site of Theodosius harbour at Yenikapi in Istanbul, Turkey. The age of this specimen was estimated by radiocarbon dating (^{14}C) as being from the period of Late Byzantium (15th century AD) (Onar *et al.* 2013). This jaw presents an anomaly in molar dentition uncommon for osteo-archaeological materials, as manifested by the presence of an additional cheek tooth (Lasota-Moskalewska 2008). It is also the only recorded occurrence of polyodontia in Equidae from the Byzantium period at the location in question (Onar *et al.* 2015).

Results and Discussion

Estimating the age, at which animals died on the basis of skeletal or dental remains, is hardly ever precise. Animals in prehistory were characterized by a slower ontogeny rate, compared to current species where there is a faster morphological puberty, manifested by more rapid dental development and closure of growth plates of long bones. Because of the geographical site of recovery of this skull, this horse was possibly an Arabian horse-type breed, whose incisor wear differs from other breeds (Muylle 2011) Additionally, when determining the

age of an individual based on dental examinations one should consider that the age norms adopted in archaeozoological research have been established in modern species (Lasota-Moskalewska 2008). Visual examination of the incisor occlusal surfaces indicated the animal was 9-11 years old, but applying another method of ageing, namely radiographic examination of the reserve crowns and roots using the guidelines for modern horses of Dixon and Copeland (1993), this specimen could be aged as between 12 - 15 years of age when it died.

Anomalies in dentition occur in both man and animals (Hillson 2005; Reitz and Wing 2008; France 2009; Waldron 2009) and they can be divided into genetic, developmental, and acquired in origin (Baker and Brothwell 1980; Hillson 2005). Malocclusion is the most common equine dental disorder and is caused by uneven attrition of the cheek teeth occlusal surface, possibly due to dietary reasons (Lasota-Moskalewska 2008).

Among the common equine developmental dental abnormalities, one should list the atavistic polydontia (typical), associated with the occurrence of a rudimentary 105/205 tooth at the beginning of the row (*wolf tooth*, *dens lupinus*) (König and Liebich 2006).

Developmental dental abnormalities include anomalies of shape and position of teeth, reduced numbers (hypodontia) or even total absence of teeth (anodontia). Hypodontia must be differentiated from where a tooth has been lost due to disease or extracted during the animal's life (acquired anomaly), and the alveoli of such teeth shows signs of healing (Chaix *et al.* 1997).

Apparent supernumerary teeth may actually be due to retention of deciduous teeth. True polyodontia may be due to random divisions of dental primordia. Horses can also have

displaced polyodontia, exemplified by a dentigerous cyst, found on the dorsal aspect of the skull in horses (Jubb and Kennedy 1963).

The true prevalence of equid supernumerary teeth is unknown, but clinical surveys have shown it to occur more commonly in incisors than in cheek teeth (Bökönyi 1974; Dixon *et al*. 1999a, 1999b; Hillson 2005), and more commonly in younger than in adult horses (Bökönyi 1974; Dixon *et al.* 2005; Hillson 2005). However in donkeys, polyodontia was identified in 4-5% of cases aged 6 years and older (Rodrigues *et al.* 2013).

Examination of photographs and radiographs of this specimen showed loss of the Triadan 406 (– but no radiographic or gross anatomic evidence of alveolar disease was evident and so this loss is likley an artefactual post-mortem loss.On gross examination, there is a slight ventral swelling of the mandible, circa 3-4 cm in length beneath the Triadan 407 and 408, with a more focal 1-2 cm wide periosteal reaction beneath the cadual root of 407. Radiography does not show any abnormalities in the overlying 407 or 408 teeth, but confirmed the presence of a localised periostitis of the ventral mandible. In an equid of this age, this swelling is very likley to be due to a local mandibular trauma that occurred many months earlier. Younger (3-5 year old) equids commonly have mandibular swellings due to eruption cysts at this site (Dixon and du Toit 2011).

There exists an apparently artefactual, superfical, vertical fracture of the lateral aspect of the mandible between 407 and 408 – that is not apparent on radiography and so this fracture is also likely to be a post-mortem artefactual fracture (Fig 3).

123 The 411 that is normally the most caudal cheek tooth, has a normal occlusal surface, i.e. and
124 contains the usual 6 pulp horns and the normal triangular occlusal shape of a mandibular
125 Triadan 411 (Dixon and du Toit 2011). Lateral radiographs (Fig 3). of this tooth shows a
126 wide reserve crown, and a poorly defined cadual root, as compared to all other cheek teeth
127 roots in this specimen – but this wide reserve crown and delayed cadual root development is
128 a common feature of the equid Triadan 411 mandibular tooth (Dixon and Copeland 1993).
129
130 As noted there is a supernumerary cheek tooth (412) present. Because of the absence of an
131 antagonist tooth, this tooth has overgrown considerably (> 1cm) in height, particualry on its
132 caudal aspect (Fig 3). If the animal had survived, this 412 overgrowth would have increased
133 greatly and eventually caused a severe clinical problem by initially lacerating the tongue and
134 soft tissues of the hard palate region during mastication and even later, possibly penetrating
135 the hard palate (Dixon 2010). Food invariably becomes impacted into diastemata that
136 commonly develop between the supernumeray and adjacent teeth leading to painful
137 periodontal disease (Dixon *et al*. 1999b; 2005; Dixon 2010).
138
139 Radiographic examaintion of the apex of this supernumerary tooth indicates this to be a
140 relatively recently (estimated to be less than 2- 3 years old) erupted tooth because there is no
141 root (enamel free apical area) developed yet, even allowing that root development in a
142 supernumerary teeth may not follow the usual pattern, and that this Byzantine period horse
143 may not have grown and developed as quickly as modern horses.There is also a lucent area
144 beneath the apex of the supernumerary tooth resembling an eruption cyst, with sclerosis of
145 the adjacent alveolar lining. However, the height of the overgrowth on this tooth may indicate
146 that the tooth has been erupted for possibly 4-6 years (Fig 3). This supernumerary tooth is
147 also possibly dysplastic because does not taper (rostro-caudally) in an apical direction like a

148 normal cheek tooth (Dixon *et al.* 2012), but instead appears to be slightly wider more
149 apically, even allowing that it is a young tooth. However, its structure is not that of a
150 connated (more than one tooth joined together) supernumerary tooth (Dixon *et al.* 2010).
151 Otherwise this tooth seems of normal morphology.
152
153 Based on the information gathered during analyses, we can conclude that the described
154 mandible belonged to a morphologically adult horse, which survived with the described
155 developmental polyodontia up to about 9 -11 years of age. There is no gross or radiographic
156 evidence that the presence of this additional tooth was causing a clinical problem to this horse
157 and it was very unlikely to have caused its death.
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161 **Authors declaration of interests**
162 No conflicts of interests have been declared.
163
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Fig 1: Incisor teeth of a Byzantine period horse recovered from Theodosius Harbour. Infundibular remnants are still present in all incisors; including a well-defined, small “cup” in 302 and irregular shaped enamel “rings” (“marks”) in 303 and 403 (black arrows).

Fig 2a: Right mandible of a Byzantine period horse recovered from Theodosius Harbour: lateral view.

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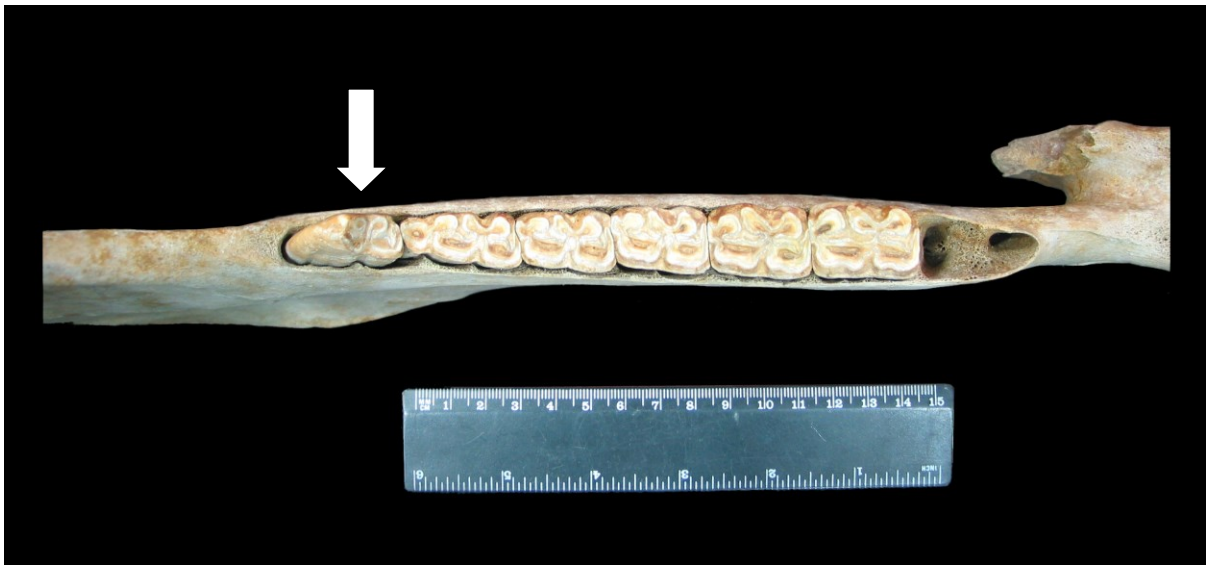
Fig 2b: Close up view of a right mandible of a Byzantine horse recovered from Theodosius Harbour: lateral view.

The 406 tooth – is missing (site indicated by star, 407, 408 , 409 , 410 , 411 (M_3),and an overgrown supernumerary tooth (412 -arrow) are present

288 

289 Fig 2c: Right mandible of a Byzantine perido horse recovered from Theodosius Harbour: dorsal view.

290 The 406 tooth is missing; and a supernumerary 412 (arrow) is present.

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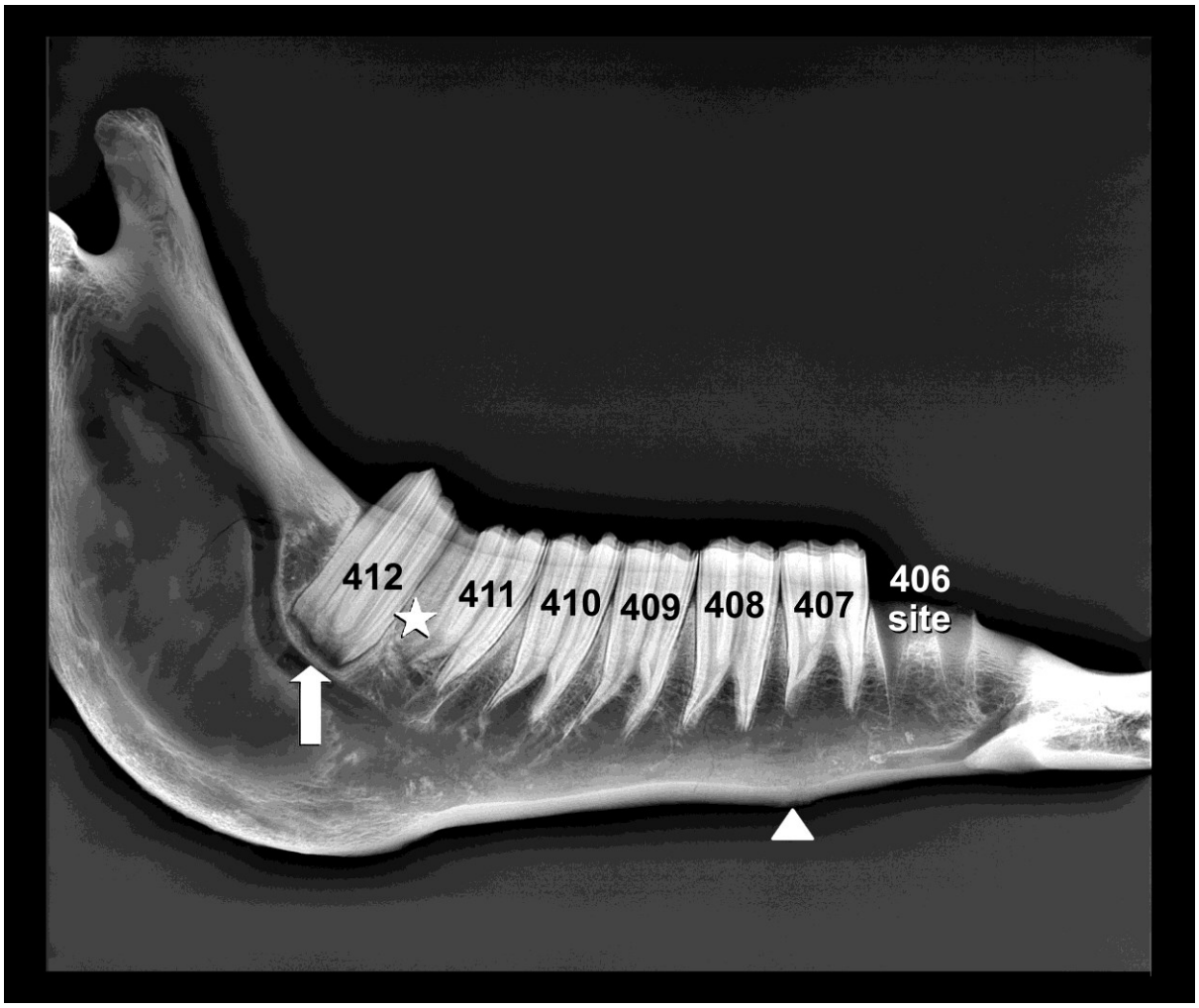

Fig 3: Lateral Radiograph of a mandible of a Byzantine period horse recovered from Theodosius Harbour with teeth labelled using the Triadan system:.

▲-indicates a swelling, circa 3-4 cm in length beneath the Triadan 407 and 408, with a more focal 1-2 cm wide periosteal reaction over the cadual root of 407; ↑- poorly defined, wide caudal root of 412.